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Horse Radish Harvesting

Draught requirements for hose radish harvesting and the effect of the lifters on the tractor

Horse radish is a Bavarian specialty grown on around 100 ha annually in the state. Because of the plant's deep rooting habit (over 40 cm) and the mainly bad weather conditions during the October to March harvest period, harvesting causes problems. To make this easier, two swing-sieve lifters have been developed which can lay the roots of the horse radish, which is grown two rows to a bed, on the surface. Investigated here are the draught requirements for both lifters as well as their effects on the draught tractor through their oscillating movements.

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The project "Ensuring horse radish cultivation" is supported by the Bavarian State Ministry for Agriculture and Forestry.

Keywords

Horse radish, lifter, traction power, acceleration

Horse radish is an intensively-grown annual crop established in April through laying 30 cm long and 1 cm thick young roots (fechser). Up to harvest, which can take place between October and March, the fechser grows into an up to 5 cm thick "stange" at the end of which at depths of up to 40 cm grow the fechser for the following planting. At harvest the stange and fechser are lifted. In that the stange has often to be stored over months and the fechser represents the plant material for the following crop, a harvesting implement is required that can lift both components in an as damage-free way as possible, even under difficult weather conditions. Currently available are two swing-sieve lifters (type A and B) with working widths of 1.3 m. Lifter A comprises two oscillating bodies arranged one behind the other whereby the foremost body also includes the share. Both oscillating bodies, and with that also the share, oscillate in the direction of travel.

Fig. 1: Horse radish harvester Type „A"

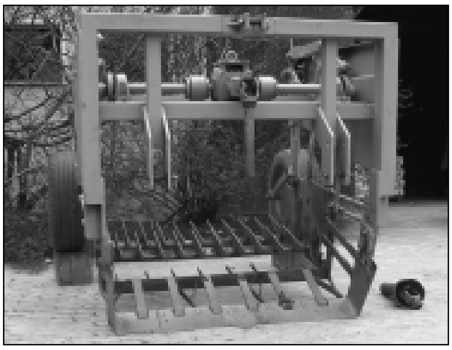

Fig. 2: Horse radish harvester Type „B"

The B lifter comprises three swing bodies arranged one behind the other and a static share. The swing bodies move in a vertical way. The first and third oscillate in parallel. The second swing body oscillates in an anti-cyclical way to the other two.

Farmers regard the associated forces applied on the tractors as very problematical. In the foreground is the draught power required of the tractors plus the impact of lifter oscillations on the driver. This has led to a preference for the B lifter with lifter draught requirements and also oscillations subjectively found to be lower, a supposition which is to be tested here.

Materials and method

The test rig presented in *figure 3* was used for determining required draught forces. During recording the lifter was attached to a carrying tractor and powered by its pto. Beneath the cab of the carrying tractor an acceleration sensor was mounted to record accelerations in driving direction. This combination (carrying tractor plus lifter) was pulled by a second tractor (draught tractor) over the

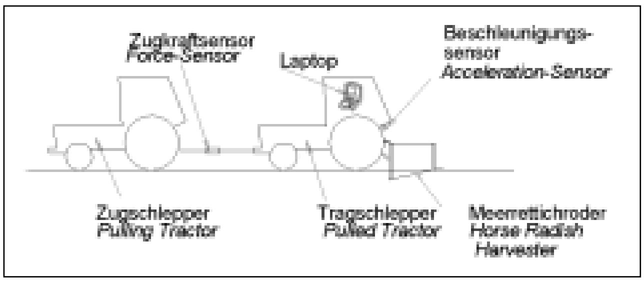

Fig. 3: Experimental design for measuring traction power and oscillation

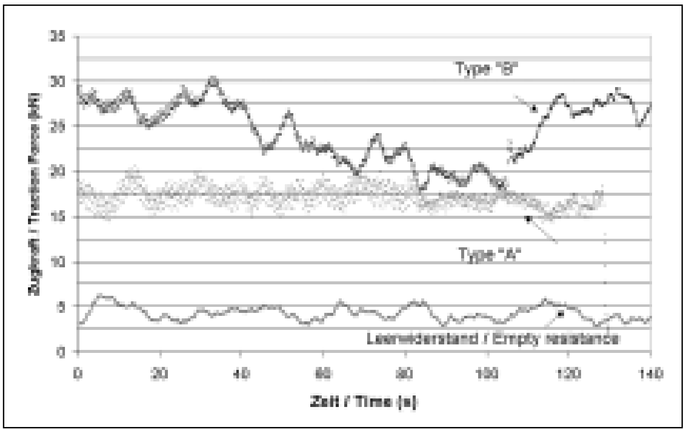

Fig.4: Traction power of two different horse radish harvester

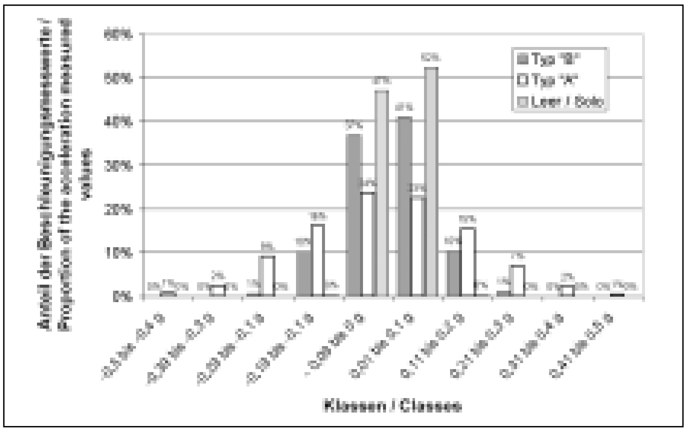

Fig. 5: Acceleration of the tractor in driving direction by different horse radish harvesters (recording rate 10 Hz)

measurement section (10 m). Both tractors were linked with a draught force recorder. Signals from the draught force recorder (recording rate 10 Hz) and from the acceleration sensor (recording rate 10 Hz) were sent to a laptop on the carrying tractor. The driving period (130 s) over the already given measurement section and the lifting depth (35 cm) were held constant during the lifting trial. The soil moisture of the high loam content sand (S14) with 15 to 15% clay was 16%.

Draught measurements

The results of the draught force measurements are presented in *figure 4*. Measurements were strongly dependent on soil conditions. It was shown that with the carrying tractor being driven empty there was a rolling resis-tance from 3.1 to 6.1 kN (Ø 4.3 kN) with scatter to factor 2. At lifting with lifter A draught force recorded was increased to 17.0 kN on average. Notable was that the measurement values compared with the measurements of the empty-run resistance were also strongly scattered over the short term so that results represented a cloud of points instead of a line. This scatter was caused by the oscillation of the lifter which expanded to the draught force recorder. The recorded draught forces moved from 15.2 to 20.2 kN. The results with lifter B showed rather the form of a line. They were, however, with an average 22.5 kN, higher than those of the A lifter. Noticeable in the run of the measurement curve are the higher values (over 25 kN) from 0 to 50 seconds followed by a decrease and then, after 100 s, beginning again. This pattern was probably caused by differing soil types. However, all measurements recorded with lifter B were above those for lifter A.

Acceleration

The results from the acceleration sensor mounted below the carrying tractor cab are presented in fig. 5. Here, the recorded values were divided into classes (class breadth 0.1 g). During an empty drive, 99% of all the acceleration values in direction of travel in both classes were from -0.09 to +0.1 g. These oscillations could have been caused by the running engine. At application of the lifter the proportion of measured values in these classes reduced to 78% with lifter B and 47% with lifter A. In the next higher classes (-0.19 to -0.1 g and 0.11 to 0.2 g) were 20% of the determined acceleration values of lifter B and 30% of the lifter A values. While with lifter A 2% of all measured values showed an acceleration greater than ±0.4 g, no measurement values are available for lifter B in these classes.

Discussion

If one compares the draught force measurement data of both lifters it is noticeable that contrary to lifter B the lifter A was apparently less sensitive to soil differences and required less draught power. These assumptions have to be confirmed in following trials. Because of the low working speed of 270 m/h there was a low draught force requirement of 1.2 kW with lifter A and 1.7 kW with lifter B although an appropriately heavier tractor (according to experience at least 4 t net weight) was required to achieve the appropriate draught force and to hold the tractor steady. The power requirement of both lifters at the pto was not investigated.

The acceleration sensor results show that through the different oscillation movements, lifter A caused stronger acceleration movements on the carrying tractor in draught direction than did lifter B. This result agreed with the results of the draught force measurements and thus confirmed the fuzzy line of the draught force measurement curve.

The reduced shock forces with lifter B in driving direction were caused by the static share and also by the vertical oscillations of the sieve bodies. The latter probably led to amplified vertical oscillations on the tractor which were not recorded. The make of tractor meant that these oscillations were dampened more than the ones in drive direction and thus caused less stress on the driver.

Summary

Horse radish is a deep-rooting crop which leads to harvesting difficulties. Two differently constructed swing-sieve lifters were tested at harvest. A first trial for determining draught force showed that lifter type A required on average around 5.5 kN less draught force than lifter B. However, lifter A caused higher acceleration in drive direction, thus causing more stress to tractor and driver so that an increased draught requirement was associated with this by the farmer. Because of the slow operational speed of the lifters very low power requirement was needed for pulling the lifters (type A 1.2 kW, type B 1.7 kW). However heavy tractors (net weight > 4 t) are needed to prevent swinging out and to apply the appropriate draught power. Measurements for recording torque requirement and thus determination of total performance have still to be carried out.